



Automotive Industry Action Group

THE-4

Seven-Step Problem-Solving Process for Truck and Heavy Equipment Suppliers

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Seven-Step Problem-Solving Process for Truck and Heavy Equipment Suppliers



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FOREWORD

Members of the Automotive Industry Action Group (AIAG) Truck and Heavy Equipment Quality Work Group developed this Seven-Step Problem-Solving Process for the Truck and Heavy Equipment industry. A primary objective of the Automotive Industry Action Group (AIAG) Truck and Heavy Equipment Quality Work Group is to assess opportunities and develop solutions to standardize quality practices. The need for common practices and procedures, has been well defined, both from direct feedback with suppliers as well as from results of surveys (e.g., AIAG/ASQ Annual Quality Survey). In addition, the need for commonality is apparent among AIAG Truck and Heavy Equipment member companies, both OEMs and suppliers. This same feedback also tells us that continuous improvement methodologies are a weakness within the Truck and Heavy Equipment industry.

To respond to this issue, the Truck and Heavy Equipment Quality Work Group addressed the need for standardizing one of the basic quality tools: problem-solving. The group concurred that a common approach (common forms, language, checklists) would help both Truck and Heavy Equipment suppliers and OEM's by:

- Providing guidance to suppliers.
- Identifying commonly used tools for each step of the problem-solving process.
- Providing checklists, tips, and guidelines for thorough implementation.
- Reducing costs by performing thorough root cause analysis.
- Supporting QS-9000 Element 4.14.

Recommendations

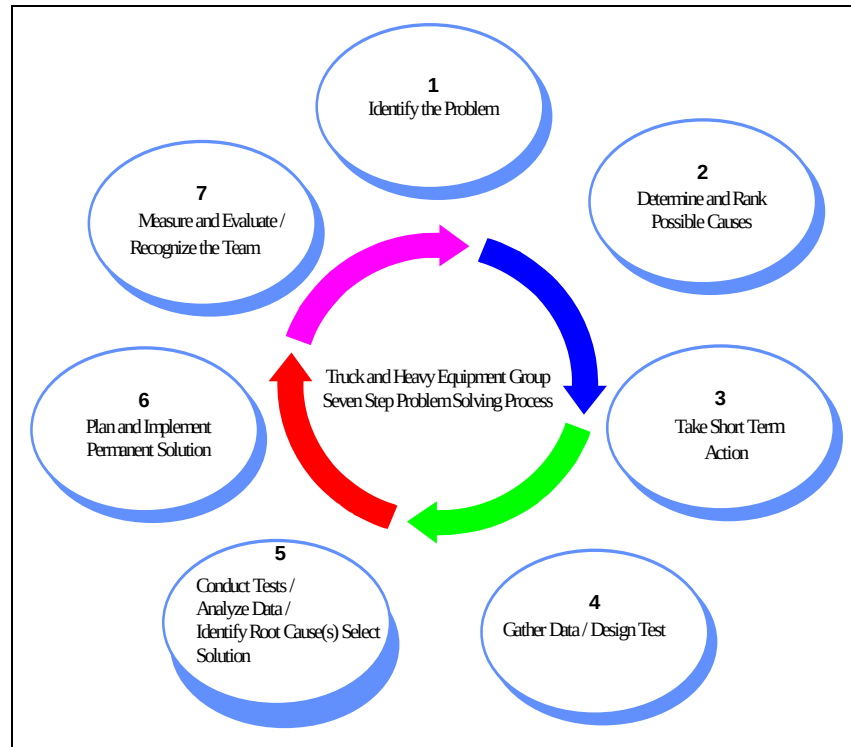
The following companies have assisted in the development, review, and deployment of this process, and are recommending this as the problem-solving methodology for their suppliers to use.

- | | |
|--|--|
| • Cummins Inc. | • Mack Trucks, Inc. |
| • Detroit Diesel Corporation | • Meritor Automotive, Inc., Heavy Vehicle Systems, LLC |
| • Freightliner LLC | |
| • Hayes Lemmerz International, Inc., Commercial Highway Division | • MetalForming Technologies, Inc. |
| | • Modine Manufacturing Company |
| • International Truck and Engine Corporation | • PACCAR Inc. |
| | • Volvo Truck Corporation |

Seven-Step Problem-Solving Process for Truck and Heavy Equipment Suppliers

The Truck and Heavy Equipment Quality Work Group Seven-Step problem-solving Process is illustrated below:

Figure 1. Seven-Step Problem-Solving Process



The Seven-Step Problem-Solving Process provides a comprehensive checklist of actions to be considered for each of the steps or phases of developing a corrective and preventive actions to a problem. The process also recommends data collection and analysis tools to be used at each step to assure the process actions are based on facts and the root cause is addressed and the solution is proven effective. In summary the steps are:

1. Identify the Problem
2. Determine and Rank Possible Causes
3. Take Short-term Action
4. Gather Data / Design Test
5. Conduct Tests / Analyze Data / Identify Root Cause(s) / Select Solution
6. Plan and Implement Permanent Solution
7. Measure and Evaluate / Recognize Team

The process also includes a corrective action response form to be used by the supplier to keep the customer informed of the status and timing of the planned actions. This Seven-Step Problem-Solving process will promote effective and permanent solutions to problems.

As part of the benchmarking process, the Truck and Heavy Equipment Quality Work Group reviewed the most commonly used problem-solving methods to ensure that all current methods were addressed. The Truck and Heavy Equipment process described in this document aligns with other Truck / Heavy Equipment / Automotive processes being used today.

This manual is structured, so that for each step of the Seven-Step Process there is a purpose statement, a list of items to consider and a list of quality tools appropriate for that step. Each quality tool, is described in Appendix B.

The Truck and Heavy Equipment Quality Work Group has also developed a T&HE industry standard reporting form for suppliers to complete and return when requested. An electronic file (on diskette) of the form is included with this manual.

Truck and Heavy Equipment Suppliers who are members of AIAG can access the manual and the standard response form through the AIAG Members Only Website and by getting a company-specific login. Go to the AIAG website (www.aiag.org), choose the *Members* option, and then click on the *Entitlements* button. You can download the entire manual and the form. For a fee, both members and non-members can obtain a bound paper copy of the document and the diskette by calling AIAG Customer Service at (248) 358-3003.

Note: Seven Step Reporting Form, needs to be a Microsoft Word .doc file.

Seven-Step Problem-Solving Process for Truck and Heavy Equipment Suppliers



ACKNOWLEDGMENTS

This document was developed by the Truck and Heavy Equipment Quality Work Group to address the Truck and Heavy Equipment industry's need for commonization.

At the time the original document was published, the following individuals contributed to the development and deployment of this common process:

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1.0 INTRODUCTION

This document is organized into the following sections:

Section 1.0 – Explains the purpose and content of this document.

Section 2.0 – Provides an overview of the Seven-Step Process, including a diagram of the process.

Section 3.0 – Provides details of purpose, expectations, and tools for each step. These bullet items and examples are designed to provide the user with additional ideas and information and to identify appropriate actions that should be considered at the appropriate step.

Appendix A – Contains a standardized reporting form to be used to communicate the status of the corrective action. Electronic versions of this file, in common formats, are available at the AIAG Web site.

Appendix B – Is a summary statement and/or example of each of the quality improvement tools. The purpose of this section is to provide a generic description of each tool, describe its basic uses, and demonstrate the use of the tool with a simple example where applicable.

2.0 PROCESS OVERVIEW

The purpose of the common problem-solving process described here is to provide a guide to help identify, document, and analyze problems. Following this process will minimize the effects of non-conforming product while defining and implementing effective, permanent solutions to eliminate problem recurrence.

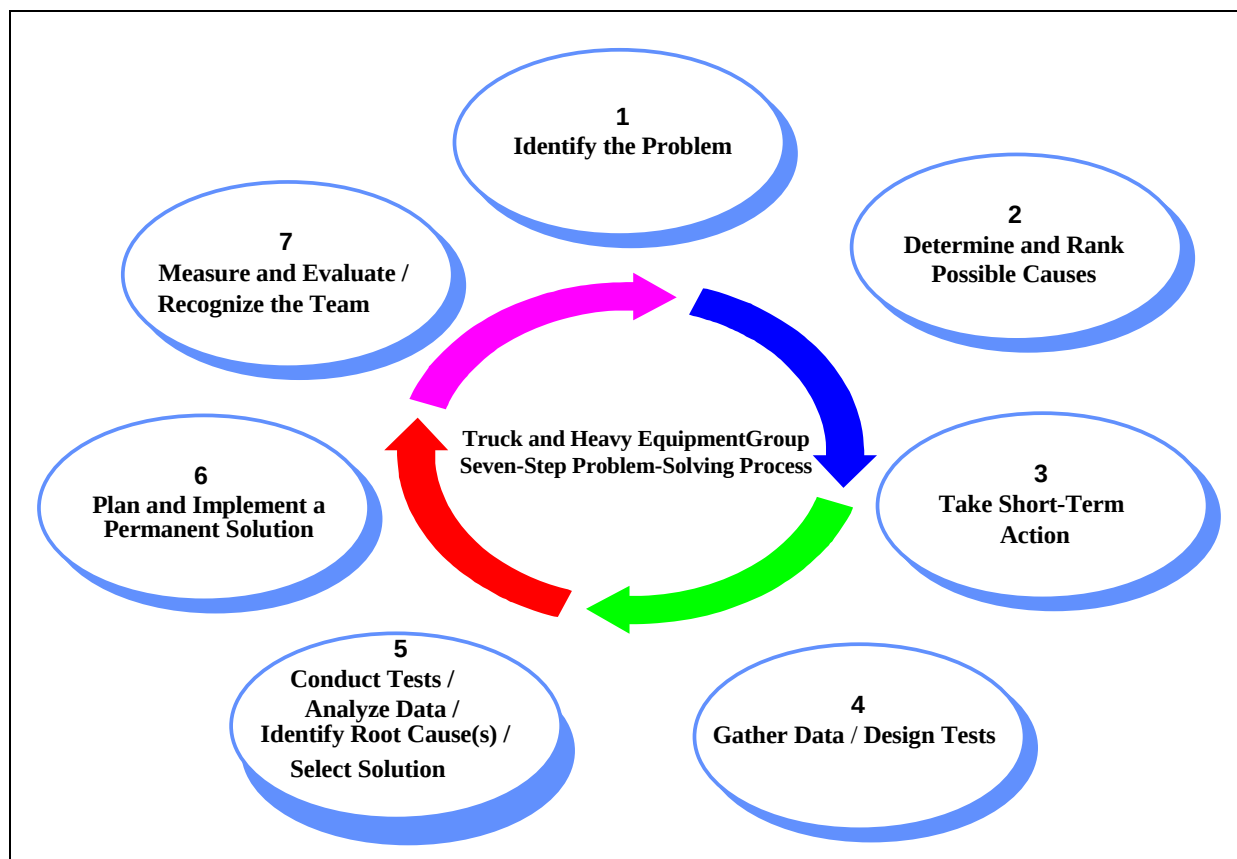
To use the seven-step problem-solving process, AIAG members may obtain a copy of the reporting form from the AIAG Member's Only web site under *Entitlements* and then by clicking on the name of the document. Non-members may order a bound copy from the AIAG Customer Service Department (248-358-3003). This copy includes a diskette with an electronic version of the form. AIAG members who would prefer a bound copy with a diskette can also order it at the member's price.

If you find that non-conforming material may have been shipped, notify the customer(s) concurrently by initiating the problem-solving process. Assemble the appropriate cross functional team and start filling in the report form. Follow the instructions in each step. Each instruction references tools that will help with problem analysis. Different types of problems will require different tools and different lengths of time to complete the process. Keep in contact with the customer(s) and provide copies of the form as it is updated during the problem-solving process. If dates for critical items change, notify the customers immediately.

2.1 Seven-Step Problem-Solving Process

1. Identify the Problem
Purpose: To define the customer-reported problem in terms related to your product, process, or requirements.
2. Determine and Rank Possible Causes
Purpose: To document all possible causes for the reported problem. Then, to prioritize and select the most likely causes(s) for a more focused approach.
3. Take Short-Term Action
Purpose: To minimize the effect of any nonconforming product by containment, re-inspection, rework, etc., to verify conformance of current product.
4. Gather Data / Design Tests
Purpose: To collect data to identify potential cause of the problem. To develop tests to define these causes.
5. Conduct Tests / Analyze Data / Identify Root Causes(s) / Select Solution
Purpose: To confirm the root cause(s) of problem; to identify and select effective solutions to eliminate root cause(s).
6. Plan and Implement a Permanent Solution
Purpose: To implement permanent solutions and verify effectiveness.
7. Measure and Evaluate for Continuous Improvement Prevent Recurrence and/ Recognize the Team
Purpose: To quantify the effectiveness of root-cause elimination and verify appropriate controls are in place to prevent recurrence, and recognize the team's achievements.

Figure 2. Seven-Step Problem-Solving Process



3.0 PROCESS DESCRIPTION

3.1 STEP 1 – Identify the Problem

Purpose

To define the customer-reported problem in terms related to your product, process, or requirements.

- Define the customer-reported problem in as much detail as possible.
- Formulate a cross-functional (multidisciplinary) team as appropriate (including customers and subcontractors.)

Note: A team may not be required for every problem-solving initiative.

- Assess overall risks by considering the following:
 - Multiple customer locations?
 - Identify severity of risk (i.e., quantities, safety, fit, form, function, etc.)
- Identify and quantify the symptoms from all sources:
 - Is the information supplied adequate?
 - What additional information is required?
 - Were parts returned?
 - Is mating part inspection needed?
 - Inspection data on problem part from customer?
 - New or changed application? Assembly/machining method?
- Analyze the symptoms to translate the reported problem into a technical problem description.
- Assimilate data into a quantifiable problem statement.

Output: Exact Definition and Quantification of the Problem.

- **What:** What is the exact problem?
- **Where:** Specification versus location on part.
- **When:** What is the frequency of occurrence?

Potential Tools:

Brainstorming
Flowcharting

3.2 STEP 2 – Determine and Rank Possible Causes

Purpose

To document all possible causes for the reported problem, prioritize and select the most likely cause(s) for a more focused approach.

Note: Step 2 and Step 3 should be concurrent activities.

- Determine Major Categories of Causes:
 - Causes can come from everywhere (including subcontractors). Most causes can be documented using a Cause and Effect diagram.
 - Identify possible process and system causes.
- Ensure that possible causes have been reduced to the lowest level of detail using the 5 Whys, brainstorming, etc.
- If possible, revisit the results of the cause-and-effect process in a subsequent meeting to allow for additional information.
- Rank Most Likely Causes:
 - It is acceptable for rank to be based on opinions and best guesses at this stage.
 - Ranks should be determined by consensus (Note: Data collection and verification will be conducted in subsequent steps.)

Potential Tools:

Brainstorming
Cause and Effect Diagram
Cause and Effect Matrix
5 Whys

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3.3 STEP 3 – Take Short-term Action

Purpose

To minimize the effect of non-conforming product by containing the symptom until the root cause is established and corrected; to verify conformance of the product in stock, and in-process.

- Protect the customer.
- Define the inspection/verification process to include (interim corrective action):
 - Inspection methods to use.
 - Which gaging to use based on measurement system analysis.
 - How to identify stock (inspected good or bad, inspections verified, stock off of process that has been re-inspected.)
 - Quarantine methods.
- Check all possible inventories and record the following for each of the locations listed below:

Table 1. Inventory Record Form

Location	Part No.	QTY	Qty Sorted	PCS Rejected	Percent
At the customer's location					
Finished inventory					
In receiving					
In process					
In transit to the customer					
At interim raw material warehouses					
At customer service locations					
Others?					
At the supplier's (your) location					
Finished inventory					
In process					
Raw materials/receiving					
Others?					
At subcontractor's (your supplier) location					
Finished inventory					
In process					
In transit to you					
Others?					

- Document the rework/repair procedure for existing non-conforming products and communicate it to the appropriate people.
 - Use existing rework/repair procedures.
 - Develop new rework/repair procedures.
 - Consider employee safety.
 - Ensure that the correct gages and fixtures are used based on measurement system analysis.
 - Obtain customer concurrence (deviation) when required.
- Perform rework/repair according to procedures and verify that all stock is acceptable.
 - Propose a stock replacement plan to the customer (special markings, mode of shipment, etc.)
 - Clearly identify inspection status as agreed to with the customer (sorted OK, reworked, off current production).
- Develop short-term actions (100% inspection) to monitor current production until root causes are verified and a permanent solution is implemented.
 - Perform 100% verification of current production.
 - Document an interim process control plan.
 - Verify that short-term actions will not create other problems or non-conformances.
 - Develop a process to ensure that short-term actions remain effective until a permanent solution is implemented.
- Notify other departments or locations where the similar problem could exist.
- Communicate to the customer all the Step 3 actions that you have taken.

Potential Tools:

Brainstorming
Checksheet
Flowcharting
Gantt Chart
Process Control Plan in Corrective Actions

3.4 STEP 4 – Gather Data and Design Tests of Causes to Quantify Their Contribution

Purpose

To collect data to identify potential cause(s) of the problem and develop tests to validate these causes.

Develop a data collection plan with responsibilities assigned to further confirm/rank the possible causes identified previously in Step 2. Any or all of the following may occur:

1. Review the actual historical process and product control documentation.
2. Run the actual production process studying product characteristics and process parameters.
3. If 1) or 2) does not replicate the reported problem, then design one or more tests to confirm potential causes and replicate the reported problem. Include all of the possible ranked causes identified in Step 2. Involve the people closest to the process.

Potential Tools:

Capability (Quality) Index
Checksheet
Concentration Diagram
Control Chart
Design of Experiments (DOE)
Histogram
Pareto Analysis
Run Chart / Trend Chart

3.5 STEP 5 – Conduct Test(s) / Analyze Data / Identify Root Cause(s) Select Solution

Purpose

To confirm the true root cause(s) of the problem, identify and select effective solutions to eliminate the true root cause(s).

- Conduct test(s) (if necessary) as identified in Step 4.
 - Don't make assumptions.
 - Conduct tests as designed.
- Analyze the results of the test(s) (or historical data) against the desired outcome.
 - Did the test(s) / historical data replicate the failure mode? If not, go back to Step 4.
 - Of the test(s) / historical data that replicated the failure mode, what is/are the most likely root cause(s)?
 - Review and update the cause and effect diagram in Step 2.
- Select the most effective solution; the most obvious may not be the most effective.
 - Process
 - Can the root cause(s) be controlled? How?
 - What systems and procedures must be changed?
 - Will the controls ensure the solution is sustained?
 - Can the controls (solution) be automated?
 - Is there a way to prevent the controls (solution) from being bypassed?
 - Design
 - Evaluate for effects on Design Failure Mode and Effects Analysis (DFMEA).
 - Review design effects on Process Failure Mode and Effects analysis (PFMEA).

Potential Tools:

Brainstorming
 Capability (Quality) Index
 Control Chart
 Decision Matrix
 Design Error-Proofing / Process Mistake-Proofing
 Design of Experiments (DOE)
 Histogram
 Hypothesis Testing
 Linear Regression Analysis
 Run Chart / Trend Chart

3.6 STEP 6 – Plan and Implement A Permanent Solution

Purpose

To implement a permanent solution and verify its effectiveness.

- Plan actions necessary to implement the solution chosen in Step 5.
 - Determine the resources needed to put the corrective action plan in place.
 - Develop a timeline for plan implementation (i.e., Gantt Chart) based on the complexity of the plan.
 - Review the plan for possible road blocks and identify ways around them.
 - Obtain the necessary management approval for the plan.
 - If the plan is complex enough to require a team effort, assess whether the initial problem-solving team has the appropriate membership or if a different implementation team should be formed.
 - Gather the team to review the strategy for putting the plan into effect.
 - Assign the tasks to be accomplished.
 - Ensure that design error-proofing/process mistake-proofing is incorporated in the plan.
 - Gain commitment.
- Implement the permanent corrective actions as planned.
 - If implemented by the team:
 - Team members begin assignments.
 - Project leader monitors progress based on milestones on the timeline.
 - Conduct team meetings to review progress, ask for assistance, etc.
 - Team works to resolve problems as they surface.
 - If it is determined that the plan cannot be implemented by the established date, notify the customer before the expected completion date.
 - If implemented by an individual:
 - Individual completes tasks necessary to implement the plan as defined.
 - Individual resolves unexpected problems as they surface.
 - If it is determined that the plan can not be implemented per established date, requests an extension prior to the expected completion date.
 - If it is determined that the plan cannot be implemented as defined or won't solve the problem as originally expected, notify the customer before the expected completion date.

Potential Tools:

Brainstorming
Design Error-Proofing / Process Mistake-Proofing
Flowcharting
Gantt Chart
Work Flow Analysis

3.7 STEP 7 – Measure and Evaluate for Continuous Improvement (Prevent Recurrence) and Recognize the Team

Purpose

To evaluate the effectiveness, through quantifiable means, of root cause elimination and to verify that the appropriate controls (both process-and system-related) are in place to prevent recurrence. To recognize the efforts and accomplishments of those participating in the problem-solving initiative.

- Study and document the results produced by the corrective action implementation.
 1. Define the methods and acceptance criteria to monitor, analyze, and document the effectiveness of the corrective action taken (i.e., inspection reports, scrap reduction analysis, productivity index measurements, throughput results).
 2. Assign qualified verification personnel to monitor, analyze, and document evidence of the corrective action's effectiveness.
 3. Gather and analyze data specific to the element addressed by the corrective action for a period of time adequate to assess the effectiveness of the implemented corrective action.
 4. If analysis indicates the corrective action has been effective according to the acceptance criteria, consider the usefulness of implementing the corrective action in other or similar applications or processes in a preventive mode.
 5. Complete the necessary system changes.
 - Review and update the Design Failure Mode and Analysis (DFMEA).
 - Modify Process Failure Mode and Analysis (PFMEA) to reflect the required changes.
 - Modify the process control plans to reflect the required changes.
 - Modify the appropriate procedures, work instructions, and/or practices to reflect the required changes.
 - Modify the appropriate engineering documentation to reflect the changes.
 - Modify the training plan and perform any required training.
 6. Review the effectiveness of sub-tier corrective/preventive actions.
 7. Review the Production Parts Approval Process (PPAP) and re-submit it if required.
 8. Gain customer approval of corrective action closure if required.
 9. Implement contingency plans immediately if corrective action is found to be less than 100% effective and return to Step 2 for further root cause analysis.
- Recognition (if used):
 - Management recognizes the team and/or individuals as appropriate.

Potential Tools:

Control Chart
Design Error-Proofing / Process Mistake-Proofing
Failure Mode and Effects Analysis
Histogram
Pareto Analysis
Process Control Plan in Corrective Actions
Run Chart / Trend Chart

APPENDIX A: SEVEN-STEP REPORTING FORM

On the following pages is a form available electronically on the diskette that accompanied this manual. This form is a recommended format for submitting corrective action request responses to the customer. The purpose of this common form is to simplify corrective action responses by providing the Truck and Heavy Equipment industry supplier with a standardized form to report corrective action findings and status.

The Seven-Step Problem-Solving Reporting Form was created to provide a convenient way for a Truck and Heavy Equipment supplier to respond to its customer on a significant quality issue and begin an immediate, formal corrective action response.

The Truck and Heavy Equipment supplier receives notification of the problem and initiates immediate action following the Seven-Step Process outlined in this document. If the Truck and Heavy Equipment supplier is a member of AIAG, the document and response form can be obtained through the AIAG website at www.aiag.org the *Members Only* section and the *Entitlement* area. Members and Non-members can order the document containing the full process description along with a diskette containing the form for a fee by calling AIAG Customer Service at (248) 358-3003.

Once the Truck and Heavy Equipment supplier has the form and is aware of the process, the following is requested:

1. Follow the Seven-Step Process as described in the document.
2. Use the recommended tools as needed for the situation.
3. Fill in the top two blocks on the form listing the customer and supplier information.
4. Fill in Steps 1, 2 and 3. The signature of the person responsible for coordination of the problem resolution is required for these three steps.
5. Return the form to the customer by email or fax within the time as specified by the customer.
6. Complete the remainder of the form and return it when the problem is resolved. Keep the customer informed of progress until the corrective action is completed.